STUDY ON HYBRID FIBRE REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH AND RICE HUSK ASH

A.Oorkalan
Department of civil engineering, K. Ramakrishnan College of Technology, Trichy-621112, Tamilnadu, India
Dr.S.Chithra
Department of civil engineering, Government College of Technology, Coimbatore-641013, Tamilnadu, India
D.Saseedharan
Department of civil engineering, K. Ramakrishnan College of Technology, Trichy-621112, Tamilnadu, India

ABSTRACT

The present experimental investigation is to study properties of hybrid fibre reinforced concrete. The concrete composite comprises of steel and polypropylene fibres in different % and partial replacement of cement by 40 % by weight. Concrete specimens were made with steel and polyprolene fibres in different proportions. Steel fibres varied from 0.5% and 1% by volume of concrete and polyprolene fibres from 0.25% and 0.5% by volume of concrete. Cement IS replaced with fly ash at 20% and rice husk ash at 20% by weight of cement. Specimens are tested for 28 days and 56 days and strength of hybrid fibre reinforced concrete were studied. Based on the test control specimens who contain cement replacement materials and no fibres, it was found that maximum compressive strength and split tensile strength of concrete is achieved with a optimum steel fibre content of 1 % and polypropylene fibre content of 0.5 %. Thus the fibres used in hybrid form increased the compressive strength and split tensile strength of concrete significantly than individually in the same concrete. The test results reveal that the increase in the compressive strength was found to vary between 1.43% to 51.72% in 28 days and the strength was found to vary between 22.87 % to 57.35% than the control concrete in 56 days and increase in the split tensile strength was found to vary between 1.56 % to 62.5% in 28 days and the strength was found to vary between 2.37% to 77.45% than the control concrete in 56 day.

Keywords: hybrid fibre, polyproplene, steel fibre, compressive strength and tensile strength

1. INTRODUCTION

Hybrid fibre-reinforced concrete is a type of fibre reinforced concrete characterized by its composition. Specifically, it contains at least two or more types of fibres of different sizes, shapes or origins. It is well known that cracking in fresh concrete can be effectively inhibited by polypropylene fibres and that different sizes contribute to different mechanical properties. This project is investigating the behavior and flexural strength of hybrid fibre reinforced concrete for partial replacement of cement with Fly ash and Rice husk ash. Two types of fibres such as steel and polypropylene are used. Steel Fibres are added

in the order of 0.5%, and1% by volume of concrete. Polypropylene fibres are added in the order of 0.25%and 0.5% by volume of concrete The Fly ash and Rice husk ash substitutes are to be used to replace Ordinary Portland Cement by each 20% by weight of cement. The total replacement level is 40%. Superior properties of concrete can be developed with the help of hybridization concept mainly to increase flexural strength of concrete. The hybrid fibre reinforced concrete composite specimens are to be tested for mechanical properties and durability related properties. The results are to be compared to the control specimen that contains no fibres and with Cement replacement materials. With the appropriate interpretation of the obtained results, it is possible to determine the optimum fibre percentage.

2. MATERIAL PROPERTIES

The cement used for this investigation is 53-grade Ordinary Portland cement. The quality of water was tested and found to satisfy the requirements of IS: 456-2000. The fine aggregate (sand) used for all the specimens was Natural River sand brought from the Vaigai river bed, Madurai, conforming to Zone III grading (which can be used for Reinforced Concrete Structures). The fine aggregate used for this investigation was sieved to pass through 4.75 mm. The coarse aggregate used was hard broken granite stone. Crushed granite metals of this passing through 12.5 mm sieve and retain on 4.75 mm sieve was used. Properties of steel and polypropylene fibre: The hooked end steel fibre was used through this programmer. The steel fibre developed which is used in this investigation was BOASEE FIBRE supplied by MJ Supplier. The Polypropylene fibre (Fibrillated) developed which are used in this investigation was BOASEE FIBRE supplied by MJ Supplier. The properties are given by the supplier.

3. EXPERIMENTAL INVESTIGATION

The below mentioned tests were conducted on M30 grade concrete with different percentage of steel fibres and polypropylene fibres. The total numbers of specimens are 216. The details of experimental programme of all tests are given in figures.

3.1 Cube compression test; Specimens used for the test were 150mmx150mm x150mm cubes. Tests were conducted using Compression Testing Machine of capacity 400 kN. The load shall be applied without shock and Increased continuously at a rate of approximately 140 kg/sqcm/min until the resistance of the specimen to the Increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete shall be noted for any unusual features in the type of failure.

3.2 Split tensile test; The test is carried out by placing a cylindrical specimen of diameter 150 mm and height 300 mm, horizontally between the loading surfaces of a Compression Testing Machine and the loading is applied until the failure of the cylinder occurs.

4. ANALYSIS AND DISCUSSION OF TEST RESULTS

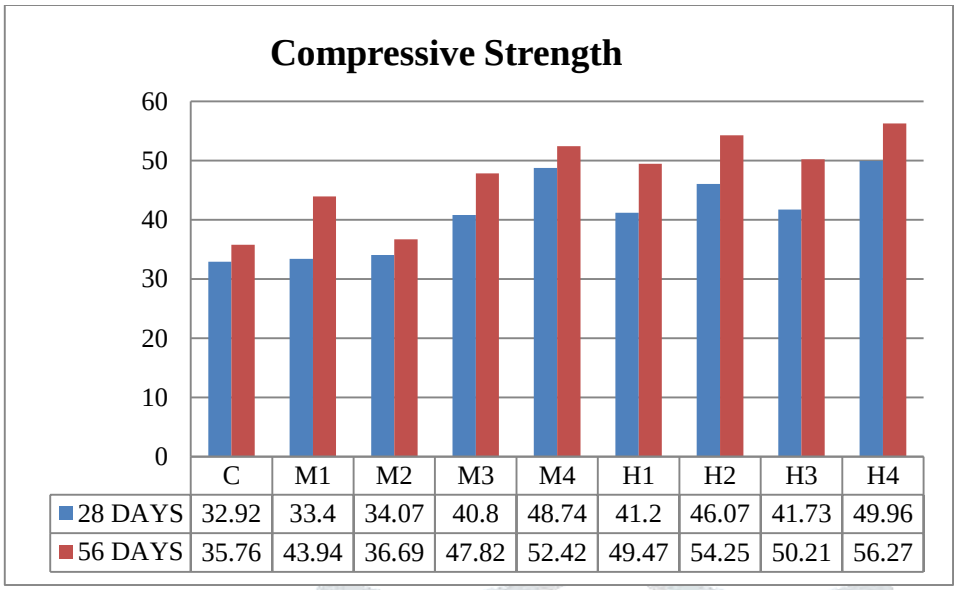
The tests on the Partial replacement of cement with fly ash and rice husk ash concrete with steel and polypropylene fibres showed the considerable improvements in properties than partial replacement of cement with fly ash and rice husk ash concrete without fibres.

4.1 Cube compression test

4.1.1 Effect of Polypropylene fibre content in concrete; Compressive strength of Partial replacement of cement with fly ash and rice husk ash concrete with 0.25% Polypropylene fibre was found to be increased by about 1.5% and 22 % for 28 days and 56 days respectively. Similarly 0.5% Polypropylene fibre was found to be increased by about 3.46% and 2.6% for 28 days and 56 days respectively.

4.1.2 Effect of Steel fibre content in concrete; Compressive strength of Partial replacement of cement with fly ash and rice husk ash concrete with 0.5% Steel fibre was found to be increased by about 23.90 % and 33.72% for 28 days and 56 days respectively. Similarly 1% Steel fibre was found to be increased by about 48.01% and 46.59% for 28 days and 56 days respectively.

4.1.3 Effect of combination of Steel fibre and Polypropylene fibre content in concrete; Compressive strength of Partial replacement of cement with fly ash and rice husk ash concrete with 0.5% Steel fibre and 0.25% Polypropylene fibre in hybrid form was found to be increased by about 25.11 % and 38.34 % for 28 days and 56 days respectively. Concrete with 0.5% Steel fibre and 0.5% Polypropylene fibre in hybrid form was found to be increased by about 39.9 % and 51.71 % for 28 days and 56 days respectively. Concrete with 1% Steel fibre and 0.25% Polypropylene fibre in hybrid form was found to be increased by about 26.72 % and 40.41 % for 28 days and 56 days respectively. Concrete with 1% Steel fibre and 0.5% Polypropylene fibre in hybrid form was found to be increased by about 51.72 % and 57.35 % for 28 days and 56 days respectively.



	C	M1	M2	M3	M4	H1	H2	H3	H4
28 DAYS	32.92	33.4	34.07	40.8	48.74	41.2	46.07	41.73	49.96
56 DAYS	35.76	43.94	36.69	47.82	52.42	49.47	54.25	50.21	56.27

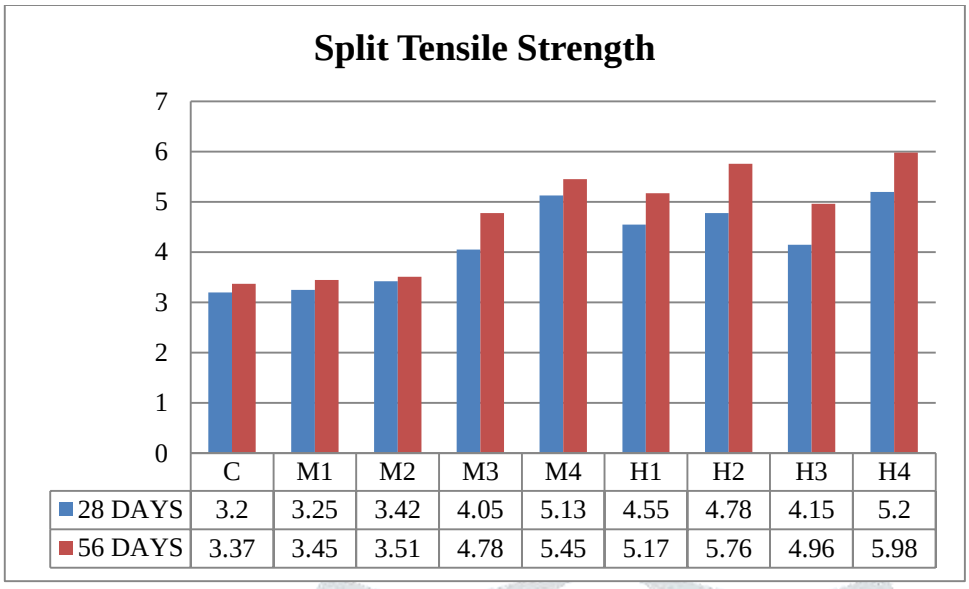
Figure 1 compressive strength of concrete with various combinations of fibres

4.2 Split tensile strength

4.2.1 Effect of Polypropylene fibre content in concrete; Split tensile strength of Partial replacement of cement with fly ash and rice husk ash concrete with 0.25% Polypropylene fibre was found to be increased by about 1.56% and 2.37 % for 28 days and 56 days respectively. Concrete with 0.5% Polypropylene fibre was found to be increased by about 6.88% and 4.15% for 28 days and 56 days respectively.

4.2.2 Effect of Steel fibre content in concrete; Split tensile strength of Partial replacement of cement with fly ash and rice husk ash concrete with 0.5% Steel fibre was found to be increased by about 26.56% and 41.84% for 28 days and 56 days respectively. Concrete with 1% Steel fibre was found to be increased by about 60.31% and 61.72% for 28 days and 56 days respectively.

4.2.3 Effect of combination of Steel fibre and Polypropylene fibre content in concrete; Split tensile strength of Partial replacement of cement with fly ash and rice husk ash concrete with 0.5% Steel fibre and 0.25% Polypropylene fibre in hybrid form was found to be increased by about 40% and 53.41% for 28 days and 56 days respectively. Concrete with 0.5% Steel fibre and 0.5% Polypropylene fibre in hybrid form was found to be increased by about 47.08% and 70.92% for 28 days and 56 days respectively. Concrete with 1% Steel fibre and 0.25% Polypropylene fibre in hybrid form was found to be increased by about 27.69% and 46.88% for 28 days and 56 days respectively. Concrete with 1% Steel fibre and 0.5% Polypropylene fibre in hybrid form was found to be increased by about 62.5% and 77.45% for 28 days and 56 days respectively.



	C	M1	M2	M3	M4	H1	H2	H3	H4
28 DAYS	3.2	3.25	3.42	4.05	5.13	4.55	4.78	4.15	5.2
56 DAYS	3.37	3.45	3.51	4.78	5.45	5.17	5.76	4.96	5.98

Figure 2 Split tensile strength of concrete with various combinations of fibres

5. CONCLUSIONS

The following are the conclusions derived from the experimental investigation carried out on the present project. Addition of two different fibres up to 1 % volume of concrete generally affects the Compressive and Split tensile strength of concrete. The Split tensile strength of concrete is increased by addition of steel fibre and polypropylene fibres in hybrid form than individually to the concrete. Therefore, it is concluded that the maximum Compressive and Split tensile strength of hybrid fibre reinforced concrete with partial replacement of cement with Fly ash and Rice Husk Ash is obtained by adding 1% steel fibre and 0.5% polypropylene fibre by volume of concrete. The usage of fibres beyond the above mentioned amount will result in the Balling effect in concrete and thus it reduces the Compressive and Split tensile strength. It was also found that the amount of fly ash and Rice husk ash can replace cement in concrete may be 40% by weight for improving its flexural strength characteristics at 56 days.

Addition of steel fibres into the concrete improves the crack resistance (or ductility) capacity and tensile strength of the concrete. Steel fibre technology actually transforms a brittle material into a more ductile one. Catastrophic failure of concrete is virtually eliminated because the fibres continue to support the load even after cracking occurs. And while measured rates of improvement vary, Steel fibre reinforced concrete exhibits higher post-crack flexural strength, better crack resistance, improved fatigue strength, higher resistance to spalling, and higher first crack strength. The function of the polypropylene fibre mixed into concrete is not to replace the steel but to avoid the formation of micro cracks in the concrete. Polypropylene fibres are used in concrete to obtain a much better, more stable surface and more resistant piece of concrete.

REFERENCES

1. ACI Committee 544, (1993) Guide for proportioning, mixing, placing and finishing fibre reinforced concrete, ACI Materials Journal, 90(1), pp .94-101.
2. IS 516-1959 (Reaffirmed 2004) Indian standard methods of tests for strength of concrete
3. Bruce, P., Effective Use of Polypropylene Fibres in Concrete, SCI Seminar 2004.
4. Aulia, T. B., Effects of Polypropylene Fibres on the Properties of High-Strength concretes. LACER No. 7 (2002), pp.43-59.
5. Hadi, M. N. S, Investigation of the Behaviour of Steel and Polypropylene Fibre Reinforced Concrete Slabs, 7th International Conference. Concrete: Construction's Sustainable Option - Harnessing Fibres for Concrete Construction, Dundee, Scotland, 8-10 July 2008.
6. Balendran R.V., Zhou F.P, A. Nadeem, A.Y.T. Leung, Influence of Steel Fibres on Strength and Ductility of Normal and Lightweight High Strength Concrete, Building and Environment, Vol.37, No.12, (2002), pp. 1361-1367.
7. Jacek Katzer, Steel Fibres and Steel Fibre Reinforced Concrete in Civil Engineering. The Pacific Journal of Science and Technology, Vol.7, No.1, May 2006 (spring), pp. 53-58
8. Julie Rapoport, Corina-Maria Aldea, Surendra P. Shah, Bruce Ankenman and Alan Karr, Permeability of Cracked Steel Fibre- Reinforced Concrete. Journal of Materials in Civil Engineering, Vol. 14, No. 4, August 1, 2002, pp.355-358.
9. Ganeshan N et al, (2007) Steel fibre reinforced high performance concrete for seismic resistant structure Civil Engineering and construction Review, December 2007, pp 54-63
10. Vikrant S Vairagade, Kavita S. Kene, Tejas R Patil, Comparative study of steel fibre reinforced concrete over control concrete, International Journal of Scientific and Research Publications, Volume 2, Issue 5, May 2012 1ISSN 2250-3153
11. Song P.S. and Hwang S (2004), Mechanical properties of high-strength steel fibre reinforced concrete, Construction and Building Materials, pp 669-676. ISSN 2250-3153